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F76 FORMULAE FOR THE COMPUTATION OF THE LINE IMPEDANCE OF A SINGLE PHASE MULTIGROUNDED DISTRIBUTION CIRCUIT

The general expression for the line impedance, Z,, in ohms per circuit mile of a multigrounded single phase line is as follows:

$$z_{L} = z_{11} - \frac{(z_{1N})^2}{z_{HN}} + \frac{1 - z_{1}}{s} z_{NO}$$

where:

Z11 (the self impedance of the phase wire with ground return expressed in ohms per mile)

$$= (R_e + R_1) + j (X_e + X_1).$$

 $R_{\rm e} \approx 0.00159$ f, where f is the frequency in cycles per second.

R, = effective resistance of phase wire in ohms per mile. The value of R; may be obtained from the manufacturers' tables or electrical handbooks.

Xe = 0.002328 f log10 4,665,600 =, where c is the ground resistivity in meter-ohms. A value of 100 meter-ohms is generally assumed if it is not otherwise specified,

X1 = inductive reactance of the phase wire in ohms per mile for one foot spacing. Values of X, are obtainable from manufacturers' tables or electrical handbooks.

Z_{NN} (the self impedance of the neutral wire with ground return expressed in ohms per mile)

$$= (R_o + R_N) + j (X_o + X_N).$$

 R_e and R_e same as in Z_{11} above;

Rw = effective resistance of neutral wire in chms per mile. This value is available from manufacturers' data or electrical handbooks . . .

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Z_{1N} (mutual impedance between phase and neutral wires with ground return expressed in ohms per mile)

$$= R_e - j (X_e - X_D)$$

Re and Xe same as in Z11 above;

$$x_D = \frac{2 \cdot f}{1000} (.741 \log_{10} p)$$

D is the spacing between phase and neutral wires in feet.

 $X_D = 0.1682$, for D = 4 (standard REA single phase spacing) and f = 60 cycles/sec.

$$Z_{NG} = R_g Z_{NN} (1 - P)$$
 tanh $R_g Z_{NN} (1 - P)$

$$R_g = \frac{R}{n}$$

R = resistance per neutral wire ground in ohms.

n = number of grounds per mile.

$$H = \frac{Z_{1N}}{Z_{NN}}$$

$$= \frac{Z_{NN}}{R_{gg}}$$

S - length of circuit in miles from power source.

The term ($\frac{1}{5}$ Z_{NO}) in the general expression of the line impedance, "Z_L", is a corrective factor which depends on the line characteristics and the length "S" of the line. This factor, for "S" equal to or greater than 10, becomes the line which is the actual case when "S" is very small, the impedance, "Z_L", becomes

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the same as that of a metallic single phase circuit. Figure 1 shows graphically the variation of impedance per mile as the length "S" of the line is varied.

References:

- 1. Engineering Report 37 and 40 of the Joint Subcommittee on

 Development and Research of the Edison Electric Institute

 and Bell Telephone Laboratories.
- 2. Electric Transmission and Distribution Reference Book, Chapter 3.

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IMPEDANCE OF SINGLE PHASE MULTIGROUNDED DISTRIBUTION LINES

Spacing: 4 Ft.

Ground Resistivity: 100 Meter-Chms

Length of Line: 10 Wiles or More

Ambient Temperature: 25° C (77° F)

Frequency: 60 Cycle

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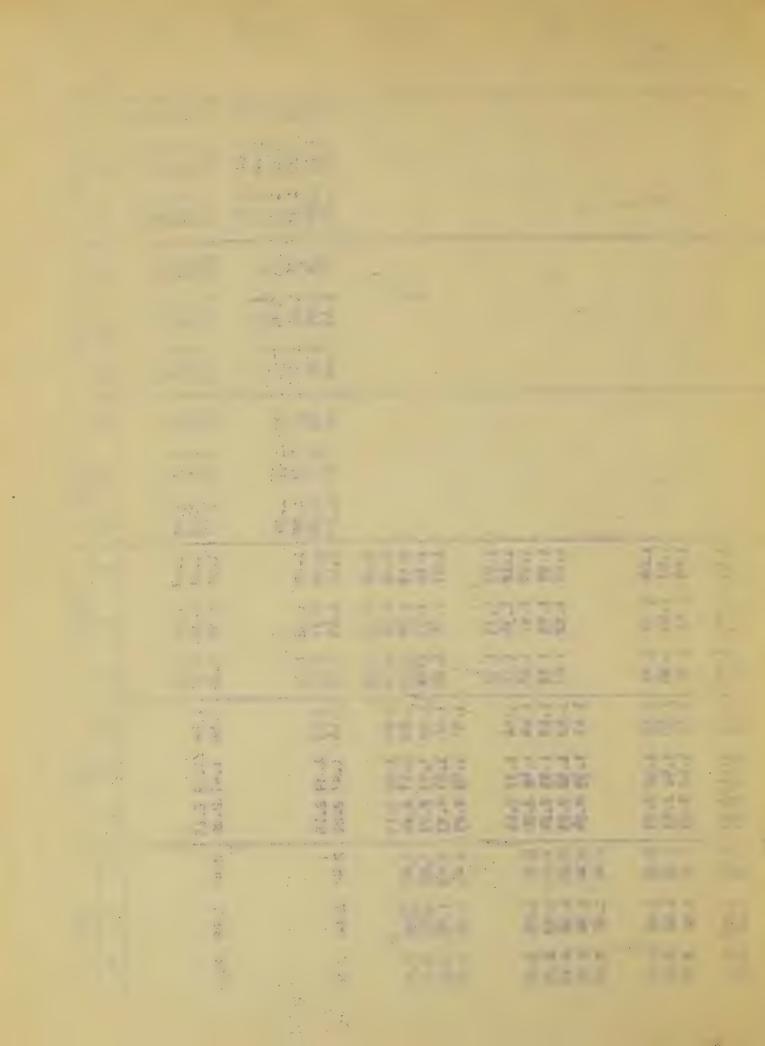
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